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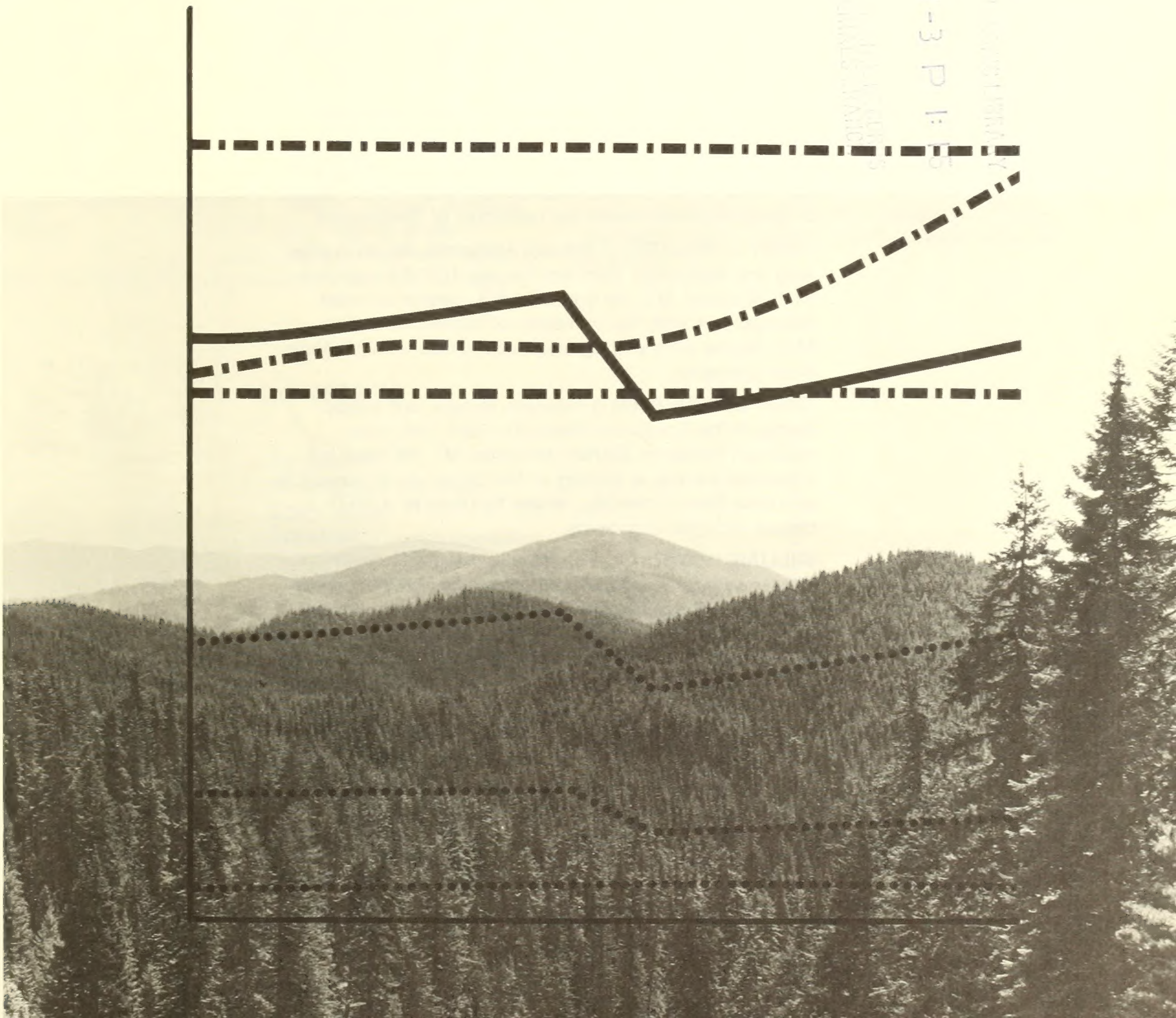
Montana's Timber Supply: An Inquiry Into Possible Futures

Patrick J. Flowers
James E. Brickell
Alan W. Green
James F. C. Hyde III
David H. Jackson
Terry L. Raettig
Ervin G. Schuster
William L. Wood



THE AUTHORS

PATRICK J. FLOWERS is supervisor, State Land Management Section, Montana Department of State Lands, Division of Forestry, Missoula, MT. He holds a B.S. degree in forest management and an M.S. degree in forest economics, both from the University of Montana.

JAMES E. BRICKELL is a forest mensurationist, Timber Management, Northern Region, USDA Forest Service, Missoula, MT. He earned forestry degrees at Washington State University and the University of Washington and completed coursework for a Ph.D. degree in forest economics and operations research at Virginia Polytechnic Institute and State University.

ALAN W. GREEN is principal resource analyst in the Forest Survey Research Work Unit, Intermountain Research Station, USDA Forest Service, Ogden, UT. In addition to a degree in economics, he holds B.S. and M.S. degrees in forestry from Purdue University.

JAMES F. C. HYDE III is an operations research analyst with the Economics Research Work Unit, Intermountain Research Station, Missoula, MT. In addition to a degree from Denison University, he holds an M.A. degree in economics from the University of Montana.

DAVID H. JACKSON is professor of forest economics, School of Forestry, University of Montana. He holds undergraduate and graduate degrees from Ohio University and the University of Oregon, respectively, and a Ph.D. degree in forest economics from the University of Washington.

TERRY L. RAETTIG is regional economist, Program Planning and Budgeting, Northern Region, USDA Forest Service, Missoula, MT. He earned a B.S. degree in forest management from the University of Minnesota and an M.S. degree emphasizing forest economics from Michigan State University.

ERVIN G. SCHUSTER is research forester and project leader of the Economics Research Work Unit, Intermountain Research Station, Missoula, MT. He received academic training in forestry at the University of Minnesota and Iowa State University, where he received a Ph.D. degree in forest economics.

WILLIAM L. WOOD is a forest economist with the Montana Department of State Lands, Division of Forestry, Missoula, MT. He holds a B.S. degree in forest management from the University of Montana, where he is also pursuing an M.S. degree.

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Intermountain Research Station
324 25th Street
Ogden, UT 84401

RESEARCH SUMMARY

Will there be adequate timber inventory available to meet future demands for forest products? Will Montana's forest industry have to substantially reduce harvest on its land in the near future? What is the role of National Forests and other nonindustry landowners in providing timber, specifically regarding their ability to offset a possible reduction in industrial harvest? What will be the status of inventory and harvesting by the year 2030? This study was designed to answer these questions.

The basic analytical tool used in this study is the Montana Timber Market Model (MTMM), a computer simulation model consisting of timber inventory and economic components. Analyses were conducted statewide and by three substate regions (northwest, southwest, and central) for lands managed by the Forest Service, U.S. Department of Agriculture, the Montana Department of State Lands, forest industry, nonindustrial private, and all other public owners. Thirty-one timber-related scenarios, combinations of timber harvest and log processing levels, were evaluated to assess their impact on timber inventory and economic variables.

Results comparing expected timber harvest and log processing levels portray a reasonably optimistic future with respect to maintaining the recent past, except for the northwest and possibly the southwest substate regions. Of the hundred-plus combinations of timber-related scenarios and geographical areas, almost 20 percent indicate a consistent surplus of deliveries over processing levels through the year 2030, about a third show a consistent deficit, and about 45 percent indicate mixed results—surplus changing to deficit or vice versa. A substantial majority of the deficits identified applies to the northwest substate region. There, the inability of forest industry to maintain harvest levels is the major factor contributing to the deficit. The outlook for the central substate region is the most optimistic, with surpluses of log deliveries over processing levels occurring in about half of the scenarios. The southwest substate region also predominantly shows surpluses, at least until early in the next century when some deficits appear.

Four scenarios are featured for in-depth discussion—High Harvest, Low Harvest, Base Harvest, and Plausible Harvest. The Base Harvest and the Low Harvest scenarios are similar, with the future looking like a continuation of the recent past until about 2000 when large declines take place. Plausible Harvest scenarios portray a future modestly above the recent past, dropping just below that level around 2005, and then rising. The High Harvest scenarios portray a future of modest but constant expansion throughout the analysis period.

The Plausible Harvest scenario consists of the most realistic harvest-related assumptions currently available. This scenario shows a statewide surplus (deliveries exceeding processing needs) until about 2005, when a deficit with respect to supply-demand equilibrium begins and lasts through the end of the analysis period (2030).

The study results have several important timber inventory and economic implications. First, there is a general statewide increase in growing stock inventory, despite decreases on forest industry lands. Second, the projected distribution of harvest by diameter classes indicates a trend toward harvest of smaller trees. Third, except for the most ambitious timber harvest scenarios, there seems to be little opportunity for timber-based employment increases to promote economic development. Finally, stumpage prices are expected to increase under all scenarios.

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INTRODUCTION

Montana could face a variety of economic and social problems in the near future as a result of impending problems related to timber supply, in the view of some concerned people. The fundamental question is: Will there be an adequate timber inventory available to meet future demands for forest products? Not surprisingly, this question focuses attention on the State's two largest suppliers of timber—Montana's forest industry and the Forest Service, U.S. Department of Agriculture.

Uncertainties surrounding timber supplies from these ownerships give rise to several related concerns. For instance: Is the forest industry harvesting timber at an unsustainable rate on its own land, especially in the northwest part of Montana? How long will it take for timber inventory to be so depleted that a reduction in harvesting is required?

Some analyses (Green and others 1985) suggest the possibility of a bleak future. In recent years, industrial lands have contributed 30 to 40 percent of the total log supply while accounting for only about 17 percent of the inventory volume.

A related question is: If industrial lands contribute less to the State's timber harvest, can harvests from National Forests or other ownerships offset the decline? Is a decreased level of total timber harvest inevitable?

Some argue (IFRC 1985) that there is more than ample timber available on the National Forests. But the availability of timber from National Forests depends on decisions regarding the availability of nontimber products as well. National Forest planning analyzes alternative land uses, ranging from emphasis on producing market commodities to emphasis on amenities and other nontimber uses. These choices have substantially different timber harvest and inventory implications.

And more questions: Even if the statewide level of timber harvest can be sustained, will there be regional shortages within the State? Has the best timber already been logged? And is what remains substantially lower in quality and smaller in size?

A multiagency study team was formed early in 1985 to address such questions. Specifically, with respect to future timber inventories and economic implications, the team set out to compare various combinations of future timber harvest levels to potential log processing needs through the year 2030. In this publication, we discuss the methods used in this study and the results, indicate study uses and limitations, and then offer some conclusions.

THE ANALYTICAL APPROACH

The modeling effort in this study is based on four premises:

1. Timber supply decisions differ among ownerships. Some owner classes have a much greater propensity to hold timber in inventory than others (Jackson 1984). Thus, supply modeling should reflect the major classes of forest landowners important to Montana.
2. The level of timber harvesting must ultimately be limited by timber inventory or the amount of timber in existence. Hence, part of the modeling effort must be devoted to keeping track of changes in the quantity and quality of existing timber as affected by future harvest and growth levels.
3. The modeling effort should be designed to investigate a variety of timber-related scenarios, not simply a single, "most likely" situation. Therefore, a set of "what if" scenarios should be identified that span the range of timber harvest and log processing possibilities, from major increases to substantial decreases.
4. The scope of study should have a sufficiently detailed focus so as to provide information and results pertaining to specific geographic and landowner classes. More specificity is better than less, and the degree of specificity achieved should be limited only by data restrictions, modeling limitations, and the need to maintain confidentiality of information concerning individual landowners.

The philosophy in these premises is manifest in the way scenarios were formulated, how the simulation model was constructed, and how the study's scope was defined.

Study Scope

Ideally, this study would be conducted with a great deal of specificity regarding landowner classes and geographic areas within Montana—the more the better. Unfortunately, data limitations pertaining to geographical classes compelled the use of relatively broad classes. This then affected specification of landowner classes.

Figure 1 shows the three distinct substate regions we used in this study. These regions largely correspond to the mountainous portions of Montana: the northwest and southwest regions generally lie west of the Continental Divide, while the central region is to the east. The boundaries for these regions were based on timber inventory considerations, each corresponding to one or more "working circles" used in the most recent Montana forest

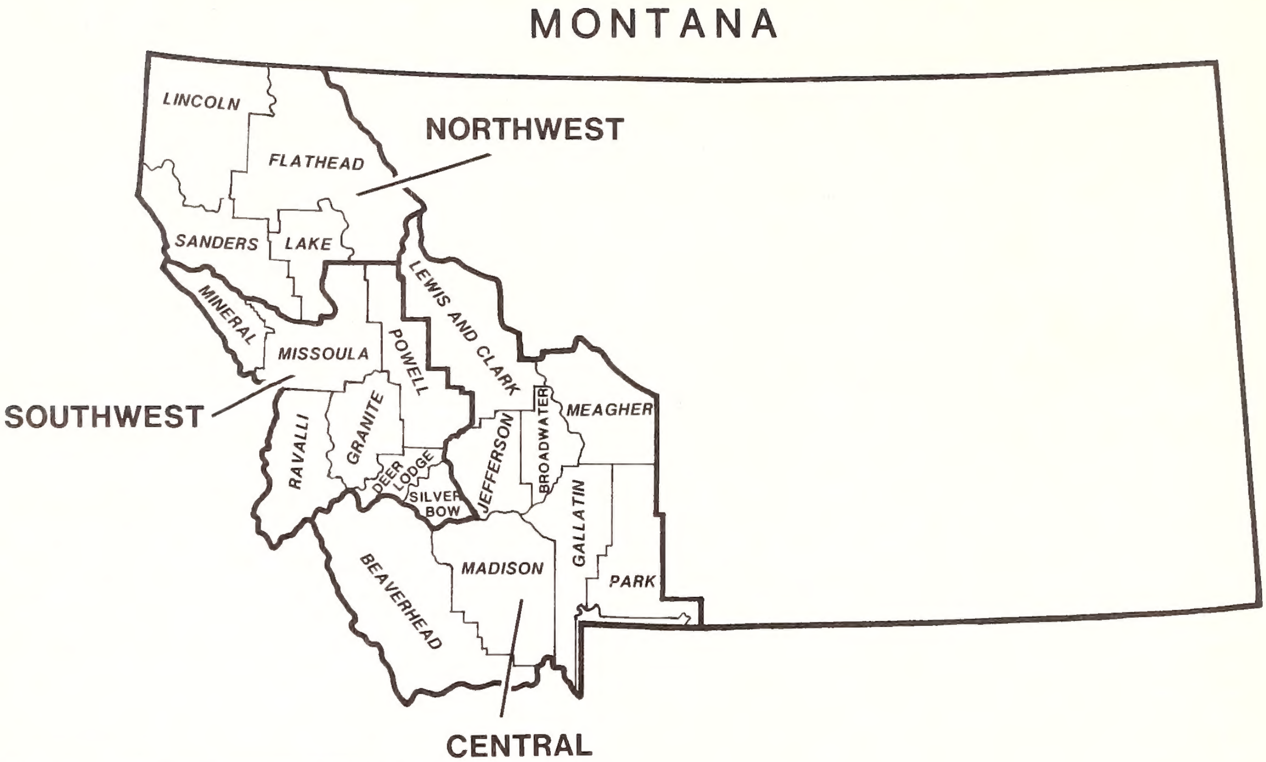

Figure 1—Multicounty analysis regions of Montana.

survey. They also correspond closely to timbershed boundaries, self-contained timber harvest and processing centers. Almost all of Montana's timber inventory and harvest activities are contained in the three designated substate regions, with the northwest accounting for the largest portion, followed closely by the southwest, and the central region a distant third.

Although there appear to be four regions, we structured our analyses around only the three. The "eastern" portion of Montana is not an analytical substate region; its harvest and inventory characteristics are reflected at the State level only. Because the eastern portion of Montana plays a relatively minor role in Montana's overall timber-based economy, little is lost by not distinguishing it as a substate region.

The following landowner classes were separately distinguished and used in this study:

Landowner classes	Land descriptions
Department of State Lands	All School Trust Lands, including the State Forest System
Forest industry	Lands owned by companies or individuals operating wood-using plants
Other or nonindustrial private	Privately owned forest land, not under forest industry ownership
USDA Forest Service	National Forests

These four landowner classes were analyzed with respect to the three substate regions shown in figure 1. These combinations account for the vast majority of the timber resource in Montana—89 percent of the growing stock inventory.

So that all forest land is included in this study, forest land not contained in a combination of specified landowner class and substate region class is included in an "other" category. This is important because of how lands in this category are treated in the Montana Timber Market Model (MTMM), discussed later. When study results are presented, harvest and delivery information for lands assigned to the "other" category for inventory manipulation are assigned back to their respective substate regions, making results presented for substate regions complete.

Scenarios

In this study a "scenario" refers to a specific combination of potential log processing levels and timber harvest levels. We postulate several log processing levels to represent potential needs of the timber-using mills in Montana's forest products industry. Harvest level possibilities reflect the ability and willingness of the forest owner classes to meet or satisfy those processing needs. In a sense, alternative levels of log processing correspond to demand aspects of the scenarios, while harvest levels correspond to the supply aspects.

In total, 31 harvest-related scenarios were evaluated. Table 1 shows that the 31 scenarios are based on three approaches to specifying log processing levels, four to specifying harvest levels for the Forest Service, and three to specifying non-Forest Service harvest.

Also, the study team developed a special scenario, Plausible Harvest, based on what was believed to represent realistic harvest-related and processing-related assumptions. This special scenario, along with three others

Table 1—Log processing and timber harvest level combinations comprising analytical scenarios used in study. Scenarios featured in depth in this publication are shown in bold typeface.

Log processing levels	Timber harvest levels: USDA Forest Service	Timber harvest levels: Other ownerships[1]	Featured scenario
Supply and demand	**Market alternatives**	**Inventory share (IS)**	**High Harvest**
		Cut = growth (C = G)	
		Recent past (RP)	
	Preferred alternatives	IS	
		C = G	
		RP	
		Special[2]	**Plausible Harvest**
	Nonmarket alternatives	IS	
		C = G	
		RP	**Low Harvest**
	Recent past	RP	
Recent past	Market alternatives	IS	
		C = G	
		RP	
	Preferred alternatives	IS	
		C = G	
		RP	
	Nonmarket alternatives	IS	
		C = G	
		RP	
	Recent past	**RP**	**Base Harvest**
Mill capacity	Market alternatives	IS	
		C = G	
		RP	
	Preferred alternatives	IS	
		C = G	
		RP	
	Nonmarket alternatives	IS	
		C = G	
		RP	
	Recent past	RP	

[1]BLM and BIA harvests always set at their recent past.
[2]"Special" consists of Montana Division of Forestry harvest set at 50 million bd ft, [redacted] private land-owner harvest at the long-term average, and all other non-Forest Service owners set at their recent past.

(named in table 1), are the "featured" scenarios in this paper. The four featured scenarios best address the key timber supply issues. In addition to Plausible Harvest, two of them represent expected extremes in future harvest levels on the National Forests and for all other owners: High Harvest and Low Harvest. The fourth is intended to portray the current frame of reference many people have, an extension of recent harvest levels into the future: Base Harvest.

Log Processing Levels—Quite clearly, the annual amount of timber ultimately processed by the mills in Montana will be determined by the economic forces of supply and demand as they operate through the markets for forest products—plywood, lumber, pulp, and paper. This study attempts to simulate that situation up to the year 2030 through use of an econometric supply-demand model for Montana timber as one approach to specifying desired processing levels.

Unfortunately, econometric supply-demand models cannot reflect all necessary economic phenomena and do not perfectly predict future levels of supply and demand. We therefore supplemented the supply-demand approach to specifying processing levels by adding two frequently discussed perspectives—the recent past processing level and the mill capacity level.

The recent past level corresponds to a short-term average, the arithmetic mean level of annual timber processed over the 5 years 1980 through 1984. This was determined by converting timber harvest data into levels of timber processed in each substate region by accounting for log movements from timber-cut origin to log-processing destination. All timber harvest (Niccolucci 1986) and 1980 interregional log movement data (Keegan 1986) were obtained from unpublished records.

Mill capacity refers to the theoretical maximum annual amount of logs that mills could use at full production. Specific criteria for full capacity vary with the type of mill (e.g., sawmill, plywood) but generally are based on two to three 8-hour shifts per day and 230 to 260 operating days per year. Actual mill capacity used is typically 70 to 90 percent of the full capacity level; this is consistent with

capacity utilization rates in United States manufacturing industries for the past 40 years (CEA 1986). Estimates of regional and statewide mill capacity were obtained from the Bureau of Business and Economics Research, University of Montana (Keegan 1986).

Timber Harvest Levels—Seven approaches were used to establish the levels of timber harvest for all but the Plausible Harvest scenario, as can be seen in table 1. Four pertain to the Forest Service and three to non-Forest Service owners.

The quantity of timber planned for harvest on Montana's National Forests is determined according to the provisions of the 1976 National Forest Management Act (NFMA) together with implementing regulations. The NFMA requires that a plan be selected from among Forest planning alternatives that vary in degree of timber emphasis and harvest. Each alternative for each Forest is associated with a different land base for managing timber (the "suitable" base) and a different schedule of timber harvests over time.

In this study, then, three of the four approaches to specifying Forest Service harvest were tied to existing Forest Service planning alternatives. Two of the alternatives encompass the range of timber harvest levels possible from the Forest Service. The "market" alternatives (emphasizing timber and other market-oriented production) establish the upper bound, and the "nonmarket" alternatives (emphasizing nonmarket or amenity-oriented outputs) represent the lower bound. The third one is termed "preferred," that planning alternative identified by National Forest officials as representing their choice as to the best plan for managing the Forest.

For any given scenario, all National Forests within the State were assumed to follow the same type of approach (table 2), such as all "preferred" alternatives. No mixing of alternatives was permitted within a scenario. Data were obtained from the harvest schedules contained in draft Forest planning documents.

In addition to harvests specified by planning alternatives, another Forest Service harvest level was specified, this one at the recent past or short-term average represented by the mean of the annual harvests from 1980 through 1984 (see table 1).

Table 2—Forest planning alternatives used to represent USDA Forest Service timber harvest approaches

National Forest	Draft date	Forest Plan alternative		
		Nonmarket	Preferred	Market
Beaverhead	1985	D[1]	H	B
Bitterroot	1985	J	E	A
Custer	1985	8	6	7
Deerlodge	1985	J	M	C
Flathead	1984	16	11	2
Gallatin	1985	3	7	2
Helena	1985	G	E	C
Lewis & Clark	1984	C	G	A-1
Lolo	1985	J	D	C
Kootenai	1985	F	J	L

[1]Readers interested in definitive descriptions of the alternatives will need to consult the appropriate draft Environmental Impact Statements for each Forest.

For non-Forest Service ownership classes, timber harvests were specified in three ways:

- **Recent past**. Annual harvest was set at the short-term average or arithmetic mean of annual harvest levels over the 5-year study period, 1980 through 1984, inventory permitting.
- **Cut = growth**. Based on timber inventory data, annual harvest was set at a level equal to net annual growth.
- **Inventory share**. Based on timber inventory data:
  Annual harvests = (timber processing volume − [Forest Service + "other" harvests]) × percentage of total non-Forest Service sawtimber volume (board foot measure) accounted for by the ownership class.

As with Forest Service harvest alternatives, no mixing of approaches among ownership classes was permitted within a scenario.

Of the 31 scenarios, only the Plausible Harvest scenario used harvest specifications different from the seven described above. In that scenario, the annual Forest Service harvests consisted of those in preferred alternatives; an annual harvest of 50 million bd ft was assumed from lands administered by the Montana Department of State Lands, the target level of harvest established for these lands (MDF 1986); [redacted] private landowner harvest was set at the long-term average, the arithmetic mean of annual harvest levels over the 15 years 1970 through 1984; and harvests from all other owners were set at the recent average.

For all 31 scenarios, annual harvest for the "other" ownership category was set equal to the recent average over the 1980 to 1984 period. Recall, this category corresponds to all ownerships in the eastern portion of Montana and any ownership in a substate region that was not specifically identified earlier.

Simulation Model

The main analytical tool used to assess resource and market implications of the various timber-related scenarios is a computer simulation model known as the Montana Timber Market Model (MTMM) (USDA FS 1984). MTMM is capable of estimating the current and future equilibrium supply-demand prices and quantities for timber, timber stumpage prices, and related employment and income, and it provides information regarding the status of the timber inventory. While MTMM is designed to operate in the economic environment of supply and demand, it can also simulate production associated with other specifications of future timber harvest and log processing levels. The primary use of MTMM is not as a tool for predicting the future, but instead as an analysis tool simulating the future.

The MTMM consists of a biological and an economic component. The biological component contains biological information used to model timber inventory. The economic component contains economic information used in economic projections of market structure and features of the wood products industry. The economic component of MTMM provides information on how much timber will be

harvested, where, and by which ownership class, based on the harvest-related scenarios specified. The biological component accepts that harvest information, adjusts the timber inventory to reflect changes resulting from the specified harvest, grows the residual stand, and waits for the next set of harvest-related instructions from the model's economic component. This process continues each year to the year 2030. In each simulation, MTMM keeps track of these biological and economic activities and provides descriptions of their variables at various points in time.

The major type of biological information used by MTMM is the forest inventory data for Montana—volumes by diameter and growth and mortality rates. Both published information (Green and others 1985) and unpublished data (Laux 1986; Long 1986) have been used. Within MTMM, the statewide timber inventory is divided into dynamic and static parts. The dynamic part pertains to the Forest Service, forest industry, Montana Department of State Lands, and nonindustrial private landowners in each of the three specified substate regions, northwest, southwest, and central. The static portion pertains to the "other" landowner class discussed earlier and includes the USDI Bureau of Indian Affairs, the USDI Bureau of Land Management, and miscellaneous public owners in those substate regions, together with all ownerships in the eastern part of Montana. This static portion of the inventory database is not updated annually with cut and growth estimates because available inventory data for those ownerships and areas are either unavailable or unreliable. Because lands in this category constitute a small fraction of Montana's timber resource (about 11 percent), possible variations in harvests from those lands would have little effect on the situations being simulated, largely immaterial to the results of the study.

The major types of economic information correspond to those required for supply-demand modeling, harvest specification and log movement, and employment impact estimation. The supply and demand equations are based on the work of Majerus (1982), Jackson (1983), and extended by Connaughton and others (in preparation). Equations are based on data from 1962 to 1980 and are applicable at the State level only. Because the equations are sensitive to both Forest Service harvest and non-Forest Service growing stock volumes, there will be a different equilibrium solution for each specification of the land area devoted to growing timber. Estimates of future timber prices are from preliminary estimates provided by Haynes (1986) for the 1985 Resources Planning Act Assessment (USDA 1981) update; those preliminary estimates were produced by the Timber Assessment Market Model (Adams and Haynes 1980) and were based on regionally specific product price and production cost projections. All prices and price computations in the MTMM are expressed in real (or constant) 1985 dollars, based on the GNP Implicit Price Deflator (CEA 1985). All economic impact multipliers used to estimate employment and income effects come from IMPLAN (Sieverts and others 1983), the Forest Service's secondary data, input-output modeling system. The multipliers produced are backward-linked, Type II. Changes in technology and gains in production efficiency will change these multipliers over time, but because these changes could not be projected, multipliers could not be updated. In effect, this study assumes constant technology, an assumption inherent to input-output methodology.

The MTMM requires a number of assumptions and known information. The most important are:

1. The volume of timber reported harvested from an owner/area inventory has been increased by 12 percent of the board foot harvest volume to account for that portion of inventory cut but not delivered to the mills—unused material and loss due to logging (adapted from Howard and Fiedler 1984).

2. Overrun is the amount by which recovered lumber, or its equivalent, exceeds the scaled (measured) volume of the logs from which the product was made. Overrun is usually expressed as a percentage of scaled volume and is greater for smaller sized trees and for more efficient manufacturing technologies. Overrun estimates are based on expert opinion (Carr 1986; Moore 1986) and are updated by means of a linear trend from 150 percent in 1984, to 170 percent in 1994, to 180 percent in 2004, and constant thereafter.

3. Real lumber and wood product prices are assumed to increase at a compound annual rate of 0.71 percent, while manufacturing, logging, and hauling costs are assumed to increase at a 0.59 percent annual rate (adapted from Haynes 1986).

4. The timber inventory for non-Forest Service lands is reduced by the following percentages to reflect areas that have been set aside and areas considered inoperable (Long 1986):

	Substate region			
Owner class	**North-west**	**South-west**	**Central**	**Eastern portion**
	Percent			
Department of State Lands	4	8	8	0
Forest industry	4	8	7	0
Nonindustrial private	12	11	8	0

5. Timber harvest schedules from individual National Forests are allocated to counties and then to substate regions on the basis of the percentage distribution of Forest acreage (net) in counties within regions.

6. Montana timber harvests are distributed from the substate region of cut origin to the substate region of processing destination according to the following percentages of origin-region harvest (1980):

	Destination substate region				
Origin substate region	**North-west**	**South-west**	**Central**	**Eastern portion**	**Other**
	Percent				
Northwest	78	16	1	0	5
Southwest	2	94	4	0	0
Central	0	14	85	0	1
Eastern portion	0	0	12	84	4

7. Montana timber imports are added to substate regional timber deliveries according to the following ratios of regional imports to regional deliveries from within Montana (1980):

Destination substate region	Imports:internal
	Percent
Northwest	0.02
Southwest	12.75
Central	8.86
Eastern portion	0

8. All board foot (bd ft) measurements of timber volume are expressed in Scribner rule.

Once the MTMM was fully specified by providing the needed biological and economic information, the model was executed—one scenario at a time. Each execution resulted in detailed descriptions of the inventory and economic implications for the various harvest scenarios. Results could be directly interpreted at the substate region level, except for the scenarios based on supply-demand solutions. Those equations are applicable only at the overall State level because comparable equations do not exist for substate regions. To assess substate implications, statewide results were disaggregated to substate regions in proportion to regional market share, based on timber processed from 1980 through 1984.

RESULTS

The objectives of this study were to compare various combinations of timber harvest levels and log processing levels (scenarios) for Montana through the year 2030 and to evaluate those combinations in terms of timber inventory and economic implications. Log processing levels reflect the demand for timber, while timber harvest levels reflect timber supply. Of the 31 scenarios analyzed, four are particularly important and will be specifically featured in later discussions.

All timber harvest levels were compared against a set of log processing levels. These processing levels represent different portrayals of mill needs. Figure 2 shows five levels for Montana. The higher of the two horizontal levels represents the annual volume of logs needed to operate Montana's mills at "full mill capacity," 1,470 million bd ft annually; this approach was used in all scenarios based on "mill capacity." The lower level, slightly over 1,000 million bd ft annually, represents the amount required to allow the mills to continue operating as in the recent past; this approach was used in all scenarios based on the "recent past." Log processing levels based on either mill capacity or the recent past average can be disaggregated to substate regions, allowing comparisons between substate processing and harvest levels.

The three upward-sloping lines in figure 2 display log processing levels resulting from the supply-demand model used to make economic forecasts. The model is sensitive to Forest Service timber harvest and non-Forest Service timber inventory. Because the size of the "suitable" timber growing base on National Forests varies with Forest planning alternative, so do the associated Forest Service timber harvest and the supply-demand model results. The High Harvest schedule reflects National Forest planning alternatives emphasizing market (largely timber) production, the Low Harvest schedule reflects alternatives emphasizing nonmarket (largely nontimber) production, and the Plausible Harvest schedule is based on the set of preferred Forest planning alternatives. The Plausible Harvest scenario represents midlevel timber harvest and log processing assumptions. Log processing schedules resulting from the supply-demand model start at about the current level of log processing and gradually rise to about 1,500 million bd ft by 2030, which exceeds the present full mill capacity. Statewide supply-demand forecasts cannot be analytically disaggregated to substate regions. To facilitate comparisons with substate harvest levels, statewide levels were assigned to regions in proportion to historical market share.

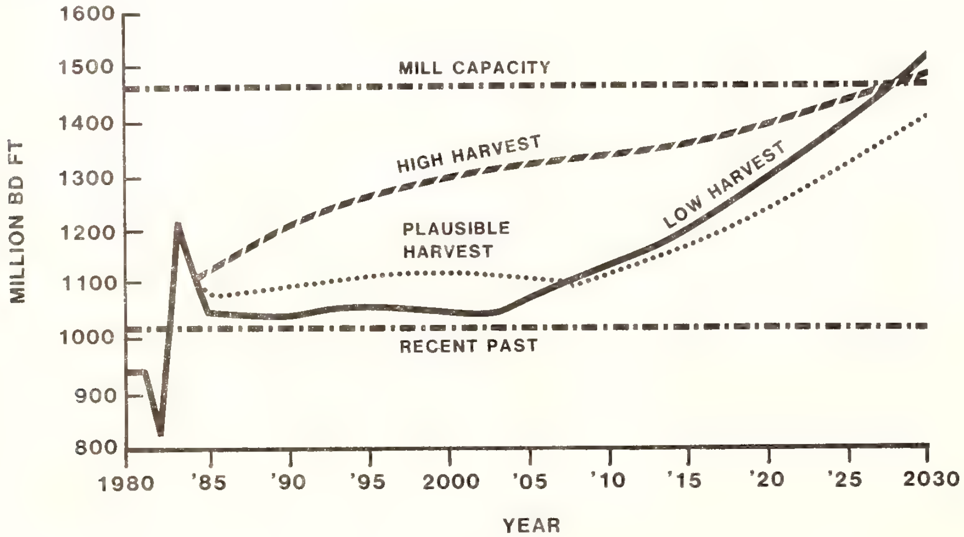

Figure 2—Montana annual log processing levels.

Comparisons of Timber Harvest and Log Processing Levels

Will the various specifications of timber harvest levels be adequate to meet the levels specified for log processing? Table 3 provides a summary for all scenarios analyzed and geographical regions evaluated in this study. Clearly, the answer depends largely on the specific combination being inspected. Of the 124 results shown, 22 (18 percent) indicate a surplus (+) of timber harvest over log processing levels throughout the duration of the analysis period, 1985 to 2030; in 40 cases (32 percent) there is a constant deficit (−); in 6 (5 percent) an equality (=); and mixed results occur in 56 cases (45 percent). A condition of equality (=) was one in which the total level of log processing was exactly met by the total level of timber harvest converted into deliveries by adjusting for interregional log movement. A surplus indicates an excess of total deliveries over the log processing level; a deficit means a shortage.

Noteworthy are the various scenarios where the "inventory share" (IS) is used to determine non-Forest Service harvest levels. First, these scenarios represent all of the equality (=) results, where the level of timber harvest is equal to the processing level specified. This is not surprising because the IS approach attempts to allocate needed timber harvest in proportion to inventory by ownership. If the inventory exists, the total allocation of harvest to owners will always exactly equal the needed harvest. Note that all equality results appear at the State level only.

Second, the IS approach provides the best depiction of the physical ability of the timber inventory to satisfy processing needs. Inspection of the Montana column shows there is enough timber to satisfy processing needs specified by the supply-demand and recent past average approaches, regardless of the Forest Service planning alternative specified. But the full mill capacity level cannot be met over the entire projection period because there simply is not enough timber inventory. A deficit develops by the year 2005 (+ −2005) when the Forest Service cut corresponds to the set of nonmarket alternatives. That is: If Forest Service timber harvests are deducted from full mill capacity processing levels, and if the remaining owner classes harvest timber in proportion to the percentage

Table 3—Summary results: timber harvest levels meeting log processing levels, by geographical area, based on log deliveries. Scenarios featured in depth in this publication are shown in bold typeface.

Log processing levels	Timber harvest levels: USDA FS	Timber harvest levels: Others	Geographical designation: Northwest	Southwest	Central	Montana	Featured scenarios
Supply and Demand	**Market alternatives**	**Inventory share (IS)**	**−**	**+ =2000−2020**	**+**	**=**	**High Harvest**
		Cut = growth (C = G)	−	= −2025	+	= +2010=2020	
		Recent past (RP)	+ −2000	+ −2000	+ −2020	+ −2000	
	Preferred alternatives	IS	− =2020	+ =2000−2020	+	=	
		C = G	−	−	+	−	
		RP	+ −2000	+ −2000	−	+ −2000	
		Special	**+ −2005**	**+ −2005**	**+ −2020**	**+ −2005**	**Plausible Harvest**
	Nonmarket alternatives	IS	− =2025	+ =2010	+	=	
		C = G	−	−	+ −2000	−	
		RP	**= −1990**	**+ =1990−2000**	**−**	**= −1990**	**Low Harvest**
	Recent past	RP	−	−	−	−	
Recent past	Market alternatives	IS	− =2025	+ =1990−2015	+	=	
		C = G	+	+	+	+	
		RP	+ −2000+2010	+	+	+	
	Preferred alternatives	IS	− =2020+2025	+ =2000−2015	+	=	
		C = G	− +1995	+	+	+	
		RP	+ −2000+2025	+ −2005	+	+ −2000+2025	
	Nonmarket alternatives	IS	− =2025	+ =2010	+	=	
		C = G	− +2005	− =2000+2005	+	− +2000	
		RP	+ −2000	+ −2000	−	+ −2000	
	Recent past	**RP**	**= −2000**	**= −2000**	**= −2000**	**= −2000**	**Base Harvest**
Mill capacity	Market alternatives	IS	−	+ −2015+2025	+ −2015	+ −2015	
		C = G	−	+	+	−	
		RP	−	+ −2000+2015	− +1995	−	
	Preferred alternatives	IS	−	+ −2005	+ −2005	+ −2005	
		C = G	−	− +1995	−	−	
		RP	−	+ −2000	−	−	
	Nonmarket alternatives	IS	−	+ −2005	+ −2005	+ −2005	
		C = G	−	−	−	−	
		RP	−	−	−	−	
	Recent past	RP	−	−	−	−	

Key: = means log deliveries equal processing level throughout analysis period, 1985 to 2030
+ means log deliveries exceed processing level
− means log deliveries below processing level.

Mixed symbols: first is condition beginning in 1985, which changes to a second condition (and perhaps later to a third) on the stated date and continues to 2030.

Note: Tolerance: total log deliveries within 1 percent of specified log processing levels.

each has of the non-Forest Service timber inventory, then harvest levels will exceed processing levels until 2005. In that year harvest level drops below the full mill capacity processing level because needed level of harvesting cannot be physically met. The deficit also develops by 2005 under the preferred alternatives. It is postponed until 2015 under the market alternatives.

Some substate regional results are also noteworthy, especially those for the northwest region. Recall from earlier discussion that concern over future timber supplies in that substate region was one factor that originally led to conducting this study. Results do, in fact, indicate a potential timber supply problem for the northwest substate region. That region accounts for 15 (38 percent) of all deficit (–) outcomes found in the study; these represent about half of the results for the northwest section. And except for one surplus (+), the remaining results are mixed. Figures in the northwest column in table 3 suggest an uncertain future, one that depends almost entirely on the scenario considered—the near-term future could be that of surplus, deficit, or equality.

The outlook for the southwest and central substate regions is not nearly as uncertain as the northwest. If negative results characterize the northwest, then surpluses characterize the central substate region, where 14 of the 31 results (45 percent) indicate surpluses and only seven deficits were found. Results from the southwest are a mixture of surpluses, deficits, and changes. Figures in the southwest and central columns in table 3 reveal that, overall, near-term surpluses prevail. Changes then begin to occur in the southwest around 2000 and slightly later in the central region.

However, because study procedures did not allow for changes in interregional log movements, substate region results should be inspected carefully. If statewide results indicate either surplus (+) or equality (=), there is enough overall timber to offset any deficits (–) at the substate level. Consider the first row of results (labeled High Harvest) shown in table 3: The northwest substate region shows a deficit (–); the central region shows a surplus (+); the southwest shows mixed results, beginning with a surplus; and the State shows equality (=). This means that the timber deliveries to the mills in the northwest (assuming no change in the existing pattern of log movements) are not enough to meet the specified processing level (established by apportioning the statewide solution to regions based on historical market share). Ample timber exists, but not in the correct place. If the pattern of log movement would change such that less timber is moved from the northwest to other substate regions or more timber is moved to the northwest from substate regions with surpluses, the northwest's deficit could be erased. Therefore, results for one subregion should be interpreted in light of both overall statewide results and those for other subregions. Changes in the location of processing capacity or log movement can be expected to mitigate regional surpluses and shortages over time.

The State—The four panels of figure 3 provide a more detailed look at the four featured scenarios for the entire State. Because several log processing levels are plotted on each panel, multiple scenarios are depicted, including some combinations that do not appear in table 3. That is, the mill capacity processing level is not part of any scenario shown, and the recent past processing level is not part of the Plausible, High, or Low Harvest scenarios.

This display convention will be used consistently in figures 3 through 6 and is intended to provide additional comparisons only. The pattern of information on each panel will remain constant: the lower lines (substate regions or owners) display timber harvest levels, upper lines (mill capacity, recent past, and supply-demand) display target log processing levels, and a middle line (total log deliveries) displays deliveries resulting from harvest levels adjusted for log movement. The reader should recall that timber harvest levels are always determined by the levels shown in table 1.

Figure 3 is a depiction of Montana's future that, more or less, also holds true for each of the substate regions. The curves for total delivery and the recent past level of log processing for the Base and Low Harvest scenarios are similar, both portraying a future comparable to the recent past until the next century at which time declines set in. The Plausible Harvest scenario provides for modest expansion over that of the recent past until the next century when deliveries more closely resemble the recent past. Finally, the High Harvest scenario provides for modest, but constant, expansion throughout the analysis period.

The Base Harvest scenario shown in the upper-left panel of figure 3 probably represents the mental picture many people have of Montana's future, that it will be an extension of the recent past. The harvest levels shown for the State and substate regions assume that all ownership classes will continue producing at the 1980 through 1984 annual average, inventory permitting. However, overall statewide drop in total deliveries around the year 2000 indicates that the timber inventory in some substate regions will be inadequate to maintain that harvest level. The sharp statewide drop in deliveries mirrors the harvest drop in the northwest substate region and to a lesser extent that of the southwest region. No harvest drop is anticipated for the central region.

As will be shown later, these harvest declines at the State and substate levels follow equal or larger declines in harvest from industry lands. Harvests from National Forest lands are constant, so there is no ability to offset the decline by industry. And after several years of declining harvest, inventories begin to build allowing harvest levels to increase. Timber harvest will support log processing levels as in the recent past until 2000, but will never reach the level that provides deliveries equal to full mill capacity.

The High and Low Harvest panels of figure 3 depict possible outcomes that, not surprisingly, range from few supply problems to many.

The High Harvest panel establishes the supply-demand model level of log processing, assuming the National Forests are managed under the set of market alternatives. Other ownerships harvest in proportion to inventory holdings. National Forest harvests are set at the planned levels, and the difference between the required processing level and National Forest harvest is made up from other ownerships on the basis of inventory share. Harvest levels under the High Harvest scenario would provide delivered logs exactly equal to the processing levels specified by the

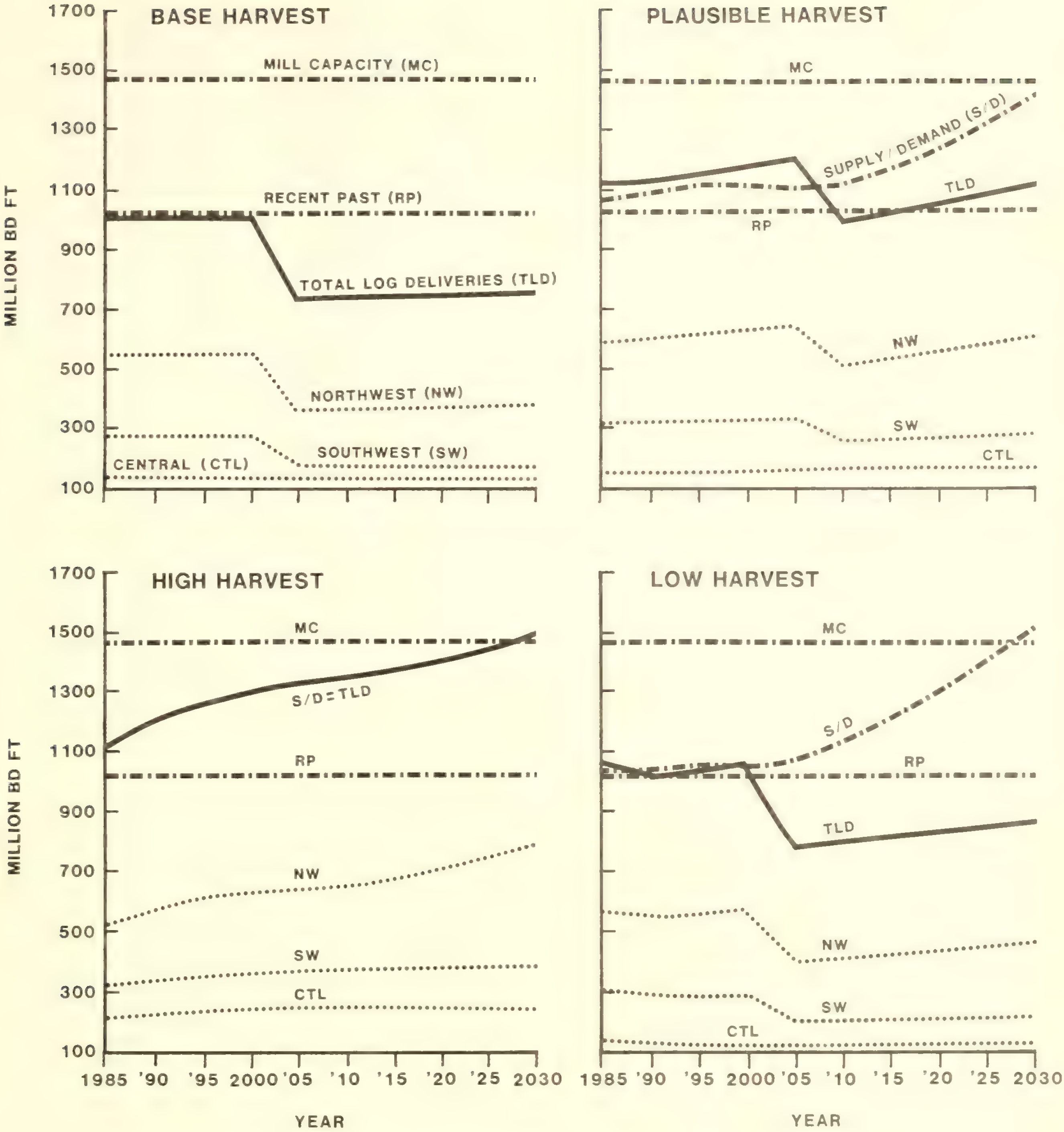

Figure 3—Annual timber harvest, log processing, and log delivery levels, by scenario and region.

supply-demand model. That level exceeds that needed to maintain processing as in the recent past, and it actually approaches that required by full mill capacity by the end of the analysis period. As shown later, this high level of harvest is almost entirely the result of increased harvesting on National Forests. Harvests in all substate regions increase. This is in sharp contrast with other scenarios that consistently show harvest decreases in the northwest and southwest substate regions.

The Low Harvest panel shows the most restrictive approach to timber harvest. Non-National Forest harvests are set at the average of the recent past, and National Forest harvests correspond to those in the nonmarket alternatives. The same (inventory-induced) harvest decrease shown in the Base Harvest scenario is present. The overall level of log deliveries initially equals but eventually drops below the log processing level specified by the supply-demand model, and the level is always far short of

the full mill capacity level. But this harvest level provides log deliveries roughly comparable to that required to maintain mills at the processing level of the recent past and that specified by the supply-demand model, at least until about 2005.

The Plausible Harvest panel sets National Forest timber harvest at the levels indicated by the preferred alternatives, the Montana Department of State Lands at 50 million bd ft annually, [redacted] private owners at their long-term average, and other ownership classes in accordance with their recent past (inventory permitting). Log processing levels are set by the supply-demand model. Because inventory again ultimately restricts harvest, overall harvest begins dropping around 2005 and increases after 2010 as inventories build. Nevertheless, until early in the next century, total harvest is always more than adequate to provide log deliveries that exceed the recent past log processing levels and that specified by the supply-demand model. Deliveries are always below the full mill capacity level. Because of the relatively higher level of harvest from National Forests, the overall harvest decline is postponed a few years compared to either the Base Harvest or the Low Harvest scenario.

Substate Regions—The four panels of figure 4 depict the scenarios for the northwest section of the State. On the Base Harvest scenario, the lower portion of the panel shows the regional level of timber harvest for the various ownerships, provided that each ownership continues to harvest as in the recent past, inventory permitting. In this scenario, forest industry's cut falls sharply around 2000 while other ownerships maintain a constant harvest. Industry's harvest decrease is a significant event portrayed by the panels for the northwest substate region. This results from inadequate inventory and is the major cause of the statewide harvest decline shown earlier in figure 3.

In actuality, the decrease in harvest is expected to be more gradual and to extend over a somewhat longer period than depicted in figure 4. The extremely sharp declines shown here and elsewhere are partially the result of the computer simulation model used and should not be literally interpreted to predict the timing of the drop. The Montana Timber Market Model depicts harvest at a steady rate until inventory is exhausted and then harvest plummets. This is because the MTMM deals with all lands within an ownership class, including forest industry lands, as if it were a single, composite entity. In fact, the forest industry sector is composed of a number of private owners, each with somewhat different inventory characteristics, making essentially independent timber harvesting decisions. Not all owners will exhaust their inventory or reduce harvest at the same time.

The upper portion of the Base Harvest scenario shows both processing levels established by the recent past average (436 million bd ft) and full mill capacity (762 million bd ft), together with the total level of log deliveries to the northwest substate region. Log deliveries to the northwest are not the same as total timber harvest in the northwest because a substantial volume of northwest harvest (about 16 percent) is delivered to southwest mills for processing. Regionally, the northwest is a net exporter. The amount of logs reaching northwest mills is always far less than full mill capacity, but is initially equal to that of the recent past before dropping considerably below by 2005.

For High and Low Harvest scenario panels in figure 4, the overall level of deliveries increases sharply for the High Harvest but remains about constant or decreases in the Low. Because the level of Forest Service harvest is so high in the High Harvest scenario, the additional level of cut needed from other ownerships to meet the processing level specified by the supply-demand model is substantially reduced. Therefore, the drop in industry harvest shown elsewhere is absent, and industry harvest actually increases. But industry harvest begins at only about 90 million bd ft in this scenario, which is substantially below that shown (about 200 million bd ft) in other scenarios and the recent past level of harvest. By 2030 the harvest barely reaches that of the starting point in other scenarios. In effect, the drop in industry harvest occurs immediately rather than later. While the overall level of log deliveries to the northwest never equals that specified by full mill capacity, it continually increases, generally lies above the level of the recent past, and approximates that specified in the supply-demand schedule by the end of the analysis period.

The Plausible Harvest panel depicts a future between that of the High Harvest scenario and that of either the Low or Base Harvest. Because Forest Service timber harvest increases constantly, the drop in industry harvest shown is smaller and later than in either that of the Low or Base Harvest approaches. Under this scenario, log deliveries to the northwest exceed the level of the recent past, except for about one decade early in the next century, and exceed the level specified by the supply-demand model during the first part of the analysis period (until 2005), but are always below full mill capacity.

The four panels of figure 5 contain comparable information for the southwest section. The format of each panel is the same as in figure 4—bottom lines display harvest levels and top lines display either total log deliveries or log processing levels. The recent past annual average of log processing in the southwest region was about 415 million bd ft, while mill capacity equals 446 million bd ft annually. And again: overall delivery decreases, resulting from drops in industry harvest, are only partially made up by smaller harvest increases from National Forests.

Several aspects of figure 5 are noteworthy. First, while the patterns of timber harvest for the southwest are similar to those of the northwest, they are at a consistently lower level. Second, nonindustrial private owners show the potential to substantially increase their harvest, with cut under the High Harvest scenario nearly double that of the Base Harvest. Third, log deliveries to the southwest substantially exceed harvest, mainly because of log movement from the northwest. About a fourth of the southwest's log deliveries come from northwest region harvests. The southwest region is a net importer of logs. Fourth, a relatively bright near-future is portrayed.

Under all but the Base Harvest scenario, log deliveries to the southwest approximate or exceed all processing level specifications for the remainder of this century. At about the year 2000, deliveries start to fall short of recent past processing levels in the Base Harvest. This occurs at about 2005 for the Low Harvest. At about 2010, deliveries

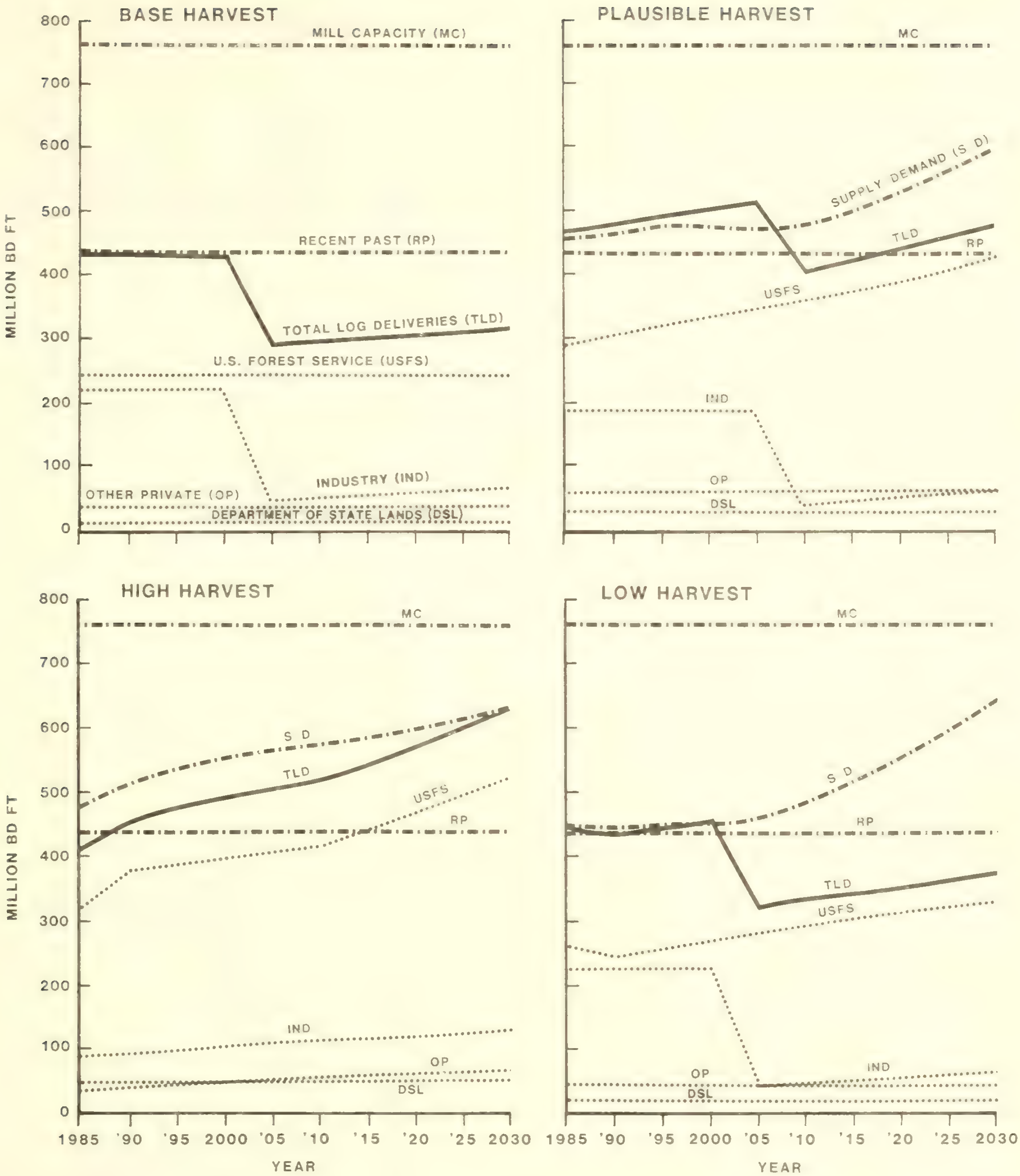

Figure 4—Northwest substate region of Montana: annual timber harvest, log processing, and log delivery levels, by scenario and ownership.

drop below the supply-demand processing levels specified in the Plausible Harvest but equal or exceed all specifications of processing levels for the High Harvest scenario. Problems facing the southwest region will likely surface sometime early in the next century. Declines in total log deliveries not only reflect drops in southwest region industry harvests, but also decreases in log movement from the northwest due to industry harvest decreases there.

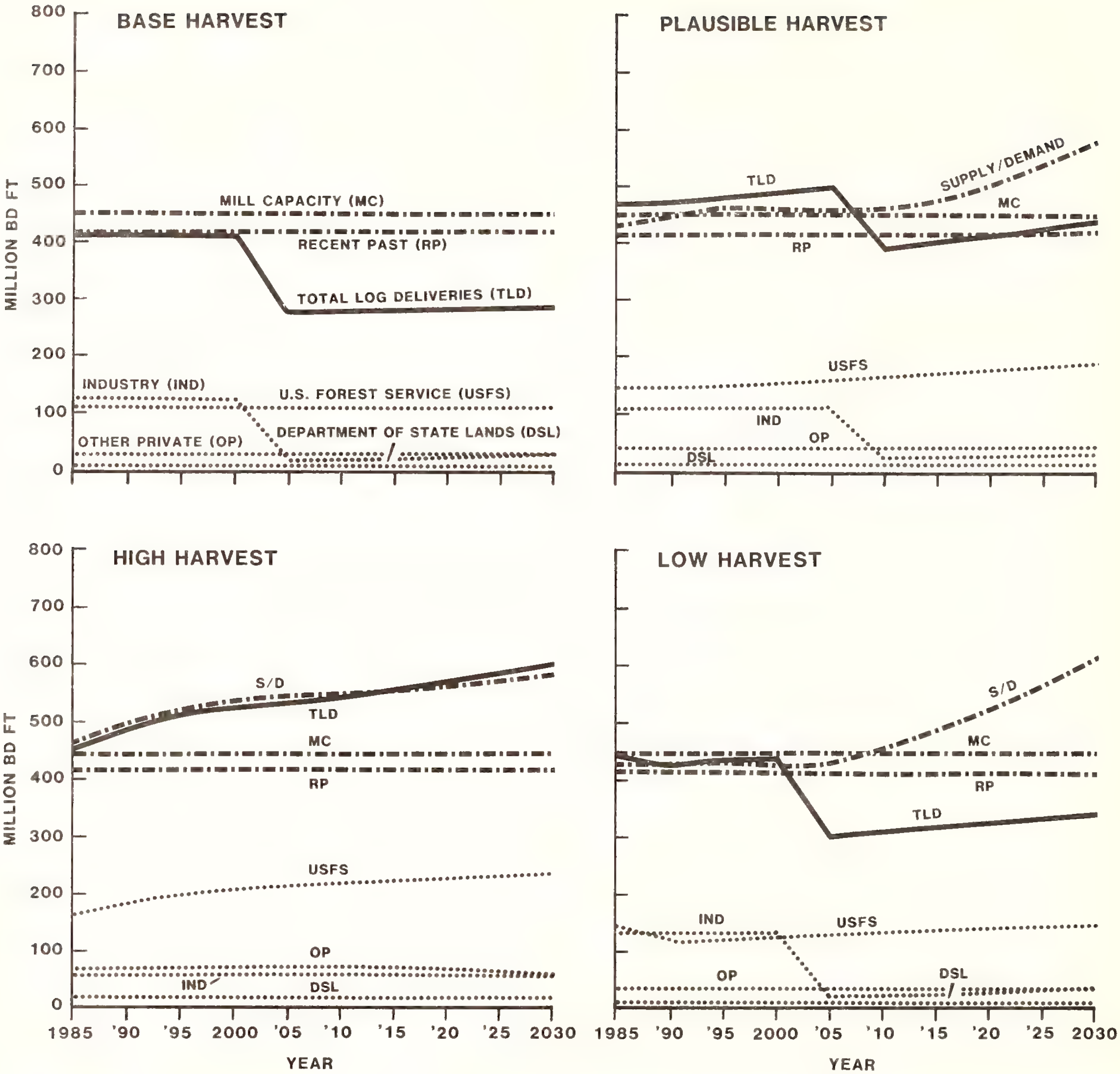

Figure 5—Southwest substate region of Montana: annual timber harvest, log processing, and log delivery levels, by scenario and ownership.

The outlook for the central substate region shown in figure 6 seems to be quite comparable to that of the southwest and brighter than in the northwest. However, the level of timber-oriented activity in the central section is by far the lowest of the three substate regions—roughly half that of the northwest. Under the Base Harvest, log deliveries almost equal that of the recent past processing level (about 140 million bd ft annually). Total deliveries drop slightly after 2000, although harvest levels remain constant. This drop is not due to harvests in the central region, but rather is due to the harvest decline in the southwest shown in figure 5; about 4 percent of that region's harvest is delivered to the central region. While log deliveries in the High Harvest scenario exceed all specifications of processing needs, they are below all specifications in the Low Harvest scenario. The Plausible Harvest scenario is mixed; deliveries always exceed the recent past level of processing (140 million bd ft annually), are always below mill capacity (190 million bd ft annually), and exceed that specified by supply-demand until about 2020 when deliveries drop below.

As in the southwest, and as shown in the High Harvest scenario, opportunities occur for increasing harvest from the nonindustrial private sector. Other noteworthy features include the absence of harvest decline from the forest industry and the relatively greater importance of the nonindustrial private sector in the central region. Given the small variation in harvest from ownerships other than the Forest Service, total deliveries mirror almost perfectly the Forest Service harvest in this region.

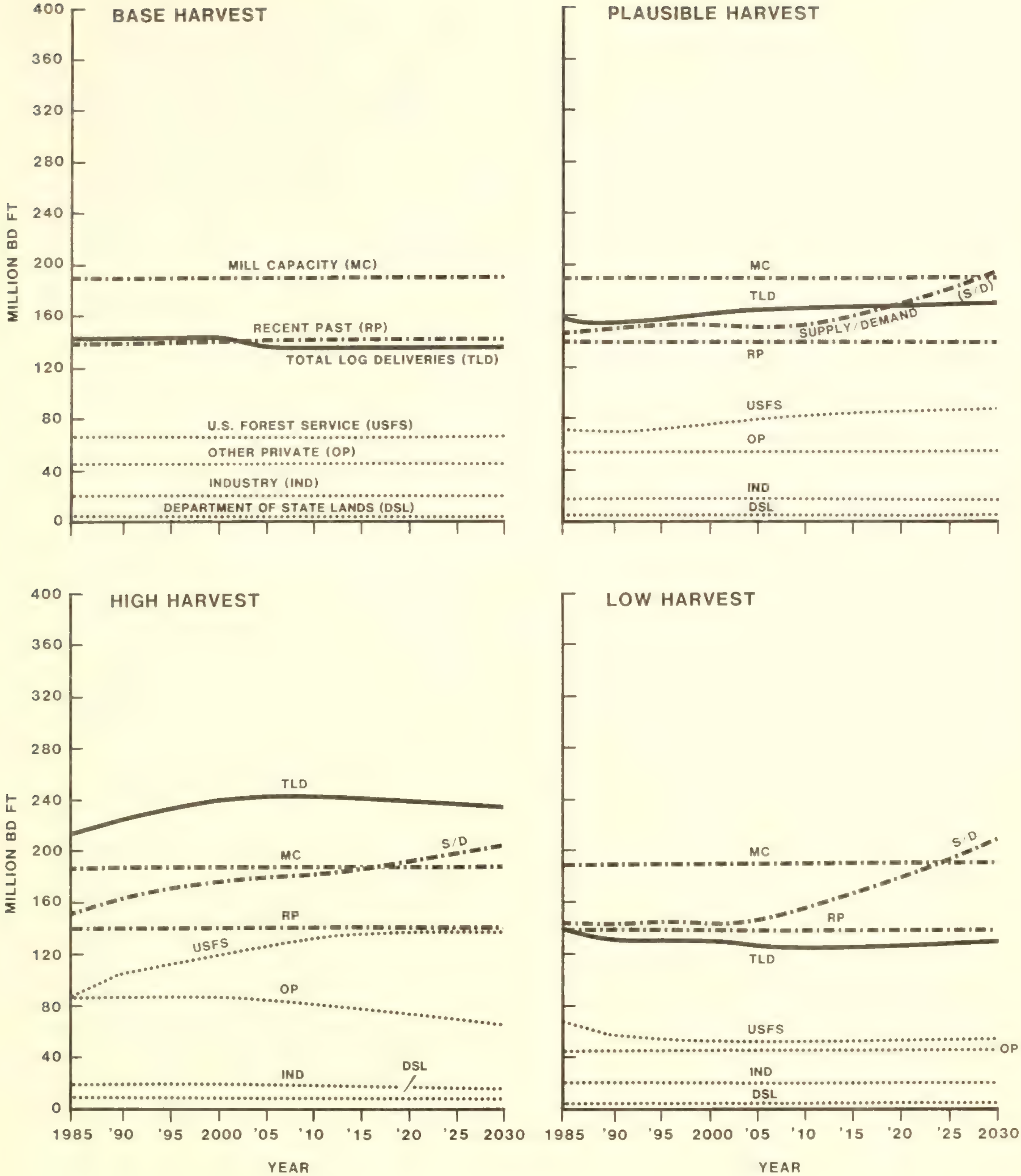

Figure 6—Central substate region of Montana: annual timber harvest, log processing, and log delivery levels, by scenario and ownership.

Inventory Implications

The various future harvest levels evaluated will have differing effects on the physical timber resource, the inventory. Because of data limitations, we cannot describe all inventory implications we feel are appropriate. For example, we recognized species mix as an important descriptor of future harvest, but it was not modeled by the MTMM and therefore cannot be addressed in this study. We use three measures to describe the composition of the future forest: total growing stock, growth-to-cut ratios, and diameter distribution for harvest.

Total Growing Stock—Future growing stock volumes are largely determined by three factors: the initial volume, net growth, and the amount harvested. Initial growing stock volumes for the National Forests vary according to the harvest specification for those lands. Each harvest specification is associated with a different suitable land base as defined by the specific Forest planning alternative. For example, in the High Harvest scenario the initial National Forest volume is at its greatest (largest "suitable" land base) while in the Low Harvest scenario it is lowest (smallest base). Starting volumes for all other owners do not vary by harvest specification because those owners are assumed to be operating from a fixed timber-growing land base.

In all four featured scenarios, statewide board foot growing stock increases over time, although at different rates (fig. 7). The High Harvest scenario shows the lowest rate of increase in growing stock because a higher harvest offsets growth to a greater degree than a lower harvest. It may appear odd, at first glance, that the Base Harvest rather than the Low Harvest scenario shows the greatest rate of increase in growing stock. This is caused by the larger, suitable National Forest land base associated with the Base Harvest scenario. The statewide growing stock levels increase even as industry growing stock is declining through the years 2000 to 2005. This occurs because the growing stock inventory on the National Forests, the other major timber supplier, is increasing at a rate faster than industry growing stock is being depleted. Both the Department of State Lands and nonindustrial private growing stocks remain relatively stable for all four featured scenarios throughout the projection period. All total, Montana's stock of timber, disregarding ownership, is increasing even under the most aggressive harvest scenario.

A sharp upturn occurs in statewide board foot growing stock in all but the High Harvest case. This upturn corresponds to the point when industry shows a sharp decline in its harvest levels, about the year 2000, as shown in figures 4 and 5. If less timber is cut, it follows that the total volume of growing stock will increase. In the High Harvest case, industry harvest is initially set at a much lower level than in the other featured cases. This lower initial level avoids a harvest falloff, and growing stock increases at a relatively steady rate.

The total board foot growing stocks for the individual areas show general upward trends similar to those found statewide. The pattern for most areas and featured scenarios is a decline in industry growing stock and increases for all other owners. One notable exception is the High Harvest scenario where the Department of State Lands and nonindustrial private growing stocks are declining, while industry growing stock is increasing. Also, in the Plausible Harvest scenario, the nonindustrial private growing stock is declining in the northwest region.

Growth-to-Cut Ratios—Growth-to-cut ratios are an index of change in total growing stock. When cut exceeds growth, the ratios will be between 0.0 and 1.0, and growing stock base will be decreasing. Conversely, when growth exceeds cut, the ratios will be greater than 1.0 and total growing stock will be increasing.

Projected statewide ratios reflect the consequences of varying, by scenario, harvest levels and the National Forest suitable land base (fig. 8). In all scenarios, board foot ratios exceed 1.0, indicating that growth exceeds cut. The Base Harvest scenario exhibits the highest ratios, the High Harvest scenario the lowest. This is consistent with the comparison of growing stock levels among scenarios: Base Harvest growing stock is largest and High Harvest stock is lowest. In the Base Harvest scenario in figure 8, a sharp rise occurs between 2000 and 2005, reflecting the sudden drop in harvest on industrial lands. In the High Harvest scenario, statewide ratios decline, indicating that more but not all of the growth will be cut.

When growth-to-cut ratios are compared across ownerships, industry exhibits the lowest ratios, always less than 1.0 over the next few decades in all but the High Harvest scenario. Eventually, industry's ratios rise to 1.0 and remain more or less fixed at that level. This rise occurs after industry removes all commercial timber, and a decrease in harvest occurs. Following the harvest decline, industry can harvest only available merchantable timber—the board foot growth. The Forest Service and Department of State Lands often show the largest ratios, with all nonindustry ratios being generally greater than 1.0, regardless of scenario. Only in the High Harvest scenario do nonindustrial private and Department of State Lands ratios drop below 1.0.

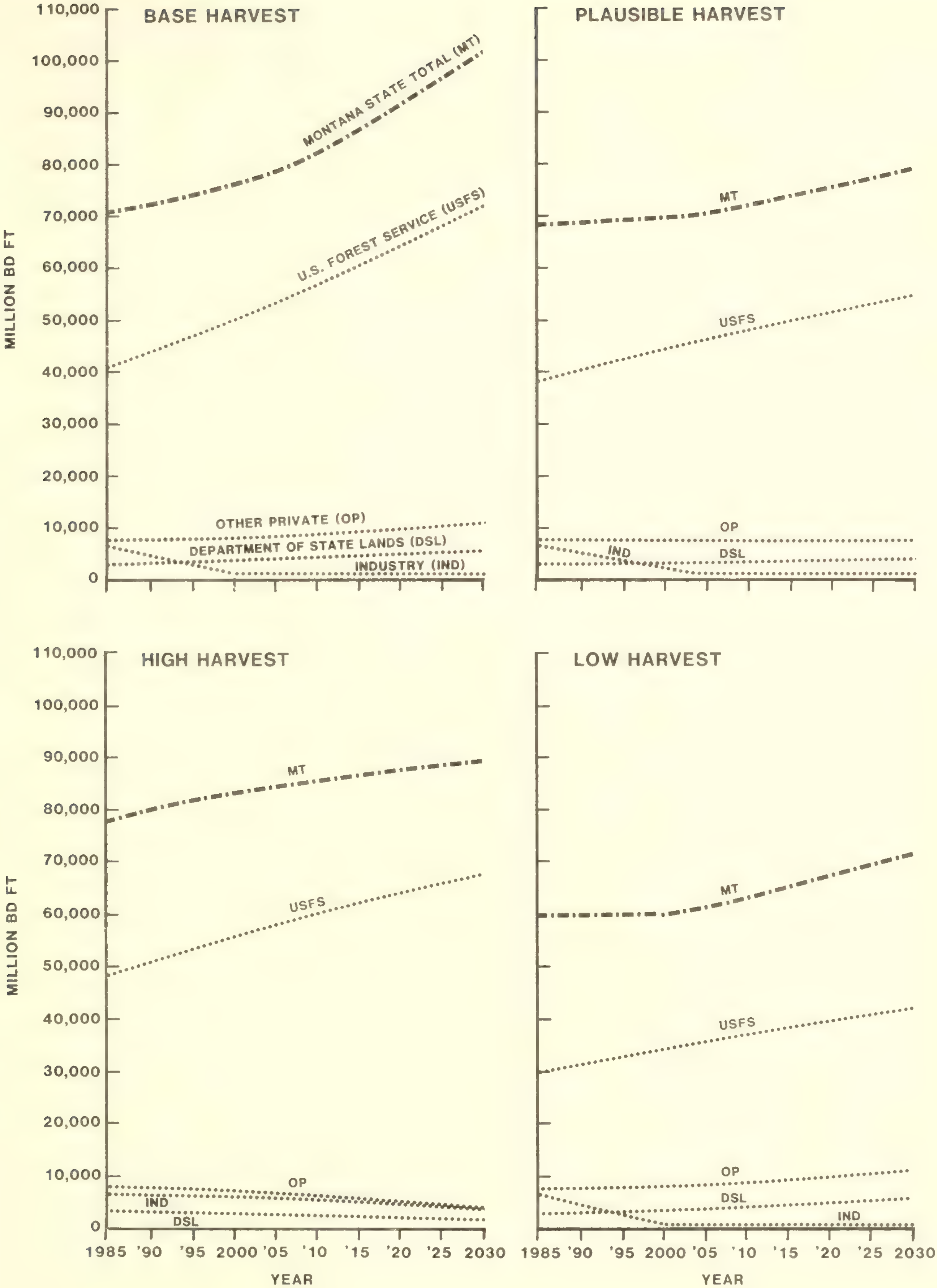

Figure 7—Growing stock volume in Montana, by scenario and ownership.

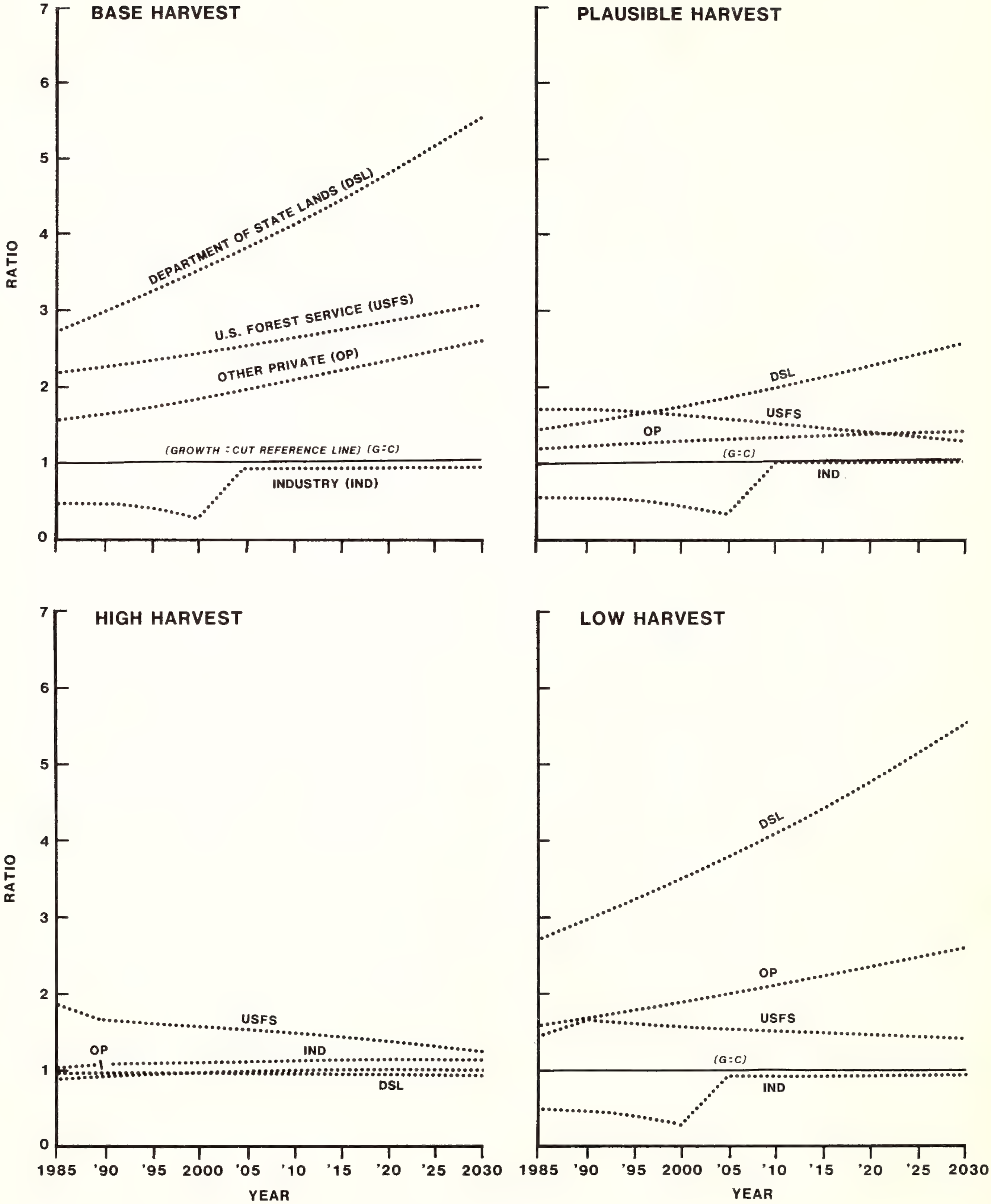

Figure 8—Growth-to-cut ratios in Montana (bd ft), by scenario and ownership.

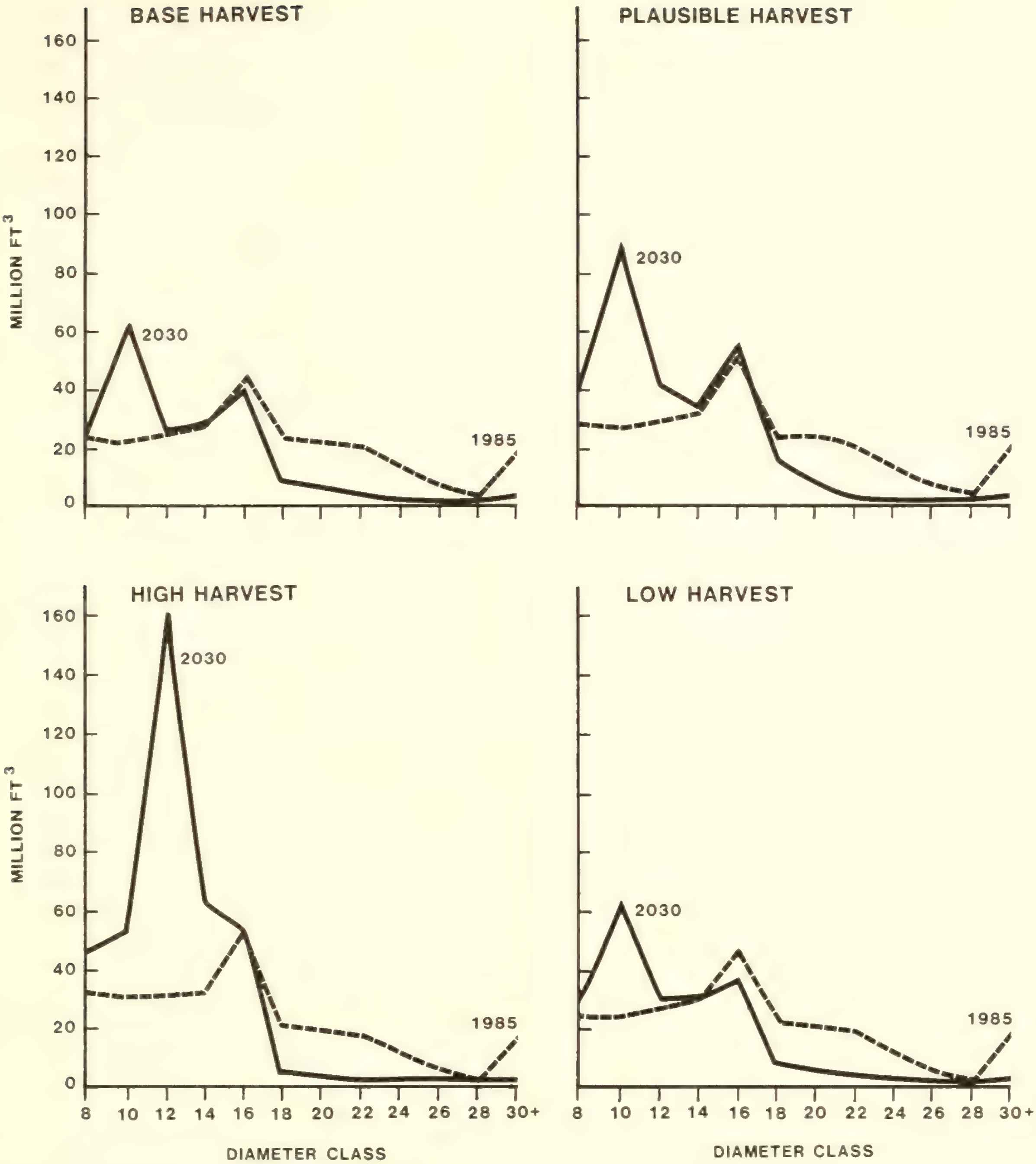

Figure 9—Diameter distribution of harvest in Montana, by scenario and region.

Diameter Distributions—A shift in the future to a harvest of smaller trees is evident when the distribution of volume harvested across diameter classes is compared for 1985 and 2030 harvests (fig. 9). In all scenarios there is a clear shift in the harvest volume to the smaller diameters in 2030. MTMM's harvest simulations show that the bulk of the harvest in 1985 came from 14-inch to 18-inch diameter at breast height (d.b.h.) trees, while in 2030 the majority is expected to come from 8-inch to 12-inch d.b.h. trees. In the featured scenarios, approximately 30 percent of the harvest volume is less than or equal to 12 inches in 1985. That rises to about 60 to 75 percent by 2030.

The change in the diameter of the harvest reflects an overall change in the distribution for the inventory. As harvests continue over the years we can expect our standing forests to be smaller than they are presently. Older growing stock is being removed and replaced by younger and faster growing timber.

Economic Implications

Obvious and perhaps not-so-obvious economic implications are associated with the timber-related scenarios analyzed. The obvious include effects on jobs and income.

The less apparent include effects on local governments through 25 Percent Fund payments, relocation of industry, and the economic quality of life. Many of these implications tend to move together—either improve or get worse. We focus on only two: employment and stumpage prices.

Employment—Timber harvested in Montana provides jobs in logging, sawmills, and other wood-processing sectors. In general, the number of jobs in substate regional economies is proportional to the quantity of timber harvested and milled. Purchases by the forest products industry within the substate regions (indirect effects), along with personal purchases by timber industry employees (induced effects), also generate employment and income in the various trade and service sectors of the local economy. The number of jobs and income resulting from timber harvesting and processing is the sum of the people directly employed, plus the indirect and induced jobs.

Figure 10 shows the total private sector employment generated by the timber harvest projected in the four featured scenarios. The employment shown, including that for 1985 and 1986, is based on harvest volumes simulated by MTMM through the analysis period. Therefore, the employment levels do not correspond to published data for 1985 and 1986. They also are different for each scenario.

According to the MTMM figures, the 1985 Montana timber harvest at the average level of the recent past provides an estimated 14,200 jobs, of which 7,500 are direct jobs in the timber industry. An additional 7,000 indirect and induced jobs result from the economic activity generated by the forest products industry. The 1985 base timber harvest of just over 1,000 million bd ft results in about 14 jobs for every 1 million bd ft of stumpage harvested. The actual employment reported for the forest products industry in 1985 was 9,369 jobs. When converted to total jobs by the appropriate multiplier, this translates to about 17,700 direct, indirect, and induced jobs in 1985. However, even though we just referenced the actual figures, employment projections should be compared among scenarios, not to actual reported employment levels.

In addition to the private sector employment modeled in MTMM, a significant number of jobs in the public sector are required to prepare and administer timber sales on public lands, but these are not modeled. Public sector timber management activities in Montana provide 1,330 direct jobs that also have added indirect and induced effects in the substate economies.

The personal income in the private sector related to the 1985 harvest in the Base Harvest scenario is $583 million annually, and in the Plausible Harvest scenario it is estimated at more than $639 million annually. These employment earnings represent a significant contribution to local and regional economies of Montana. Because most of the forest products manufactured in Montana are shipped out of State, the wages and salaries of workers in the forest products industry are part of the economic base of Montana.

Most timber-related employment is concentrated in the northwest and southwest substate regions of Montana, as shown in the lower portion of each panel in figure 10. Consequently, changes in the level of timber harvest will have a more significant effect on the economies of these two regions. Because the number of jobs related to the timber harvest is proportional to the annual timber harvest, changes in employment over time follow the same trends as the harvest.

For both the Base and the Low Harvest scenarios, only minor changes in employment occur until the year 2000. Then a substantially sharp drop of more than 25 percent occurs over the following decade. After that drop, employment levels increase gradually through 2030. The decrease in employment in the decade following the year 2000 is due to the reduction in harvest by forest industry as timber inventory is depleted. The steepness of the decline in industry harvest is a reflection of the way the MTMM calculates inventory, growth, and harvest. If harvest declines were spread over a longer period, the employment drop would also be more gradual. Increases in harvest on National Forest lands in these two scenarios are not large enough to offset the decrease in harvest by the industrial ownerships. The projected employment declines occur only in the northwest and southwest regions where industry currently is most prevalent.

In contrast, the High Harvest scenario projects a significant, steady increase in employment as harvests increase throughout the analysis period. This scenario begins with a level of employment 10 percent over that associated with the recent past, and by 2030 it ends at a level over 50 percent higher. The most significant increases in employment are in the northwest and southwest, reflecting that harvests would increase the most in these regions.

In the Plausible Harvest scenario, employment begins slightly above that of the recent past and gradually increases until the year 2005. Then employment decreases sharply as industrial harvests decline. Following the decrease, the level of employment, as shown in figure 10, is at recent past levels. For the remainder of the analysis period, employment steadily increases as inventories gradually accumulate and harvests increase, ultimately ending at a level modestly above existing employment levels. Again, the drop beginning in the year 2000 is most significant in the northwest and southwest substate regions.

Stumpage Prices—Supply-demand equations are used to provide estimates of both equilibrium quantity and price. These price estimates are most valid for the scenarios that assume relatively unconstrained supply behavior. Timber harvest levels specified by the inventory share (IS) method best portray that behavior. When the IS method is applied, total harvest (proxy for supply) will exactly equal the processing level (proxy for demand), inventory permitting; reality is then in accord with the supply-demand model's equilibrium solution. In other scenarios where the harvests from the various ownership classes are set at a level below the quantity demanded (as specified by the supply-demand model) there would be upward pressure on prices. There would be downward pressure if harvests were set above the equilibrium quantity. Earlier discussions of surplus and deficit refer only to the mathematical relationship between timber processing and harvest levels.

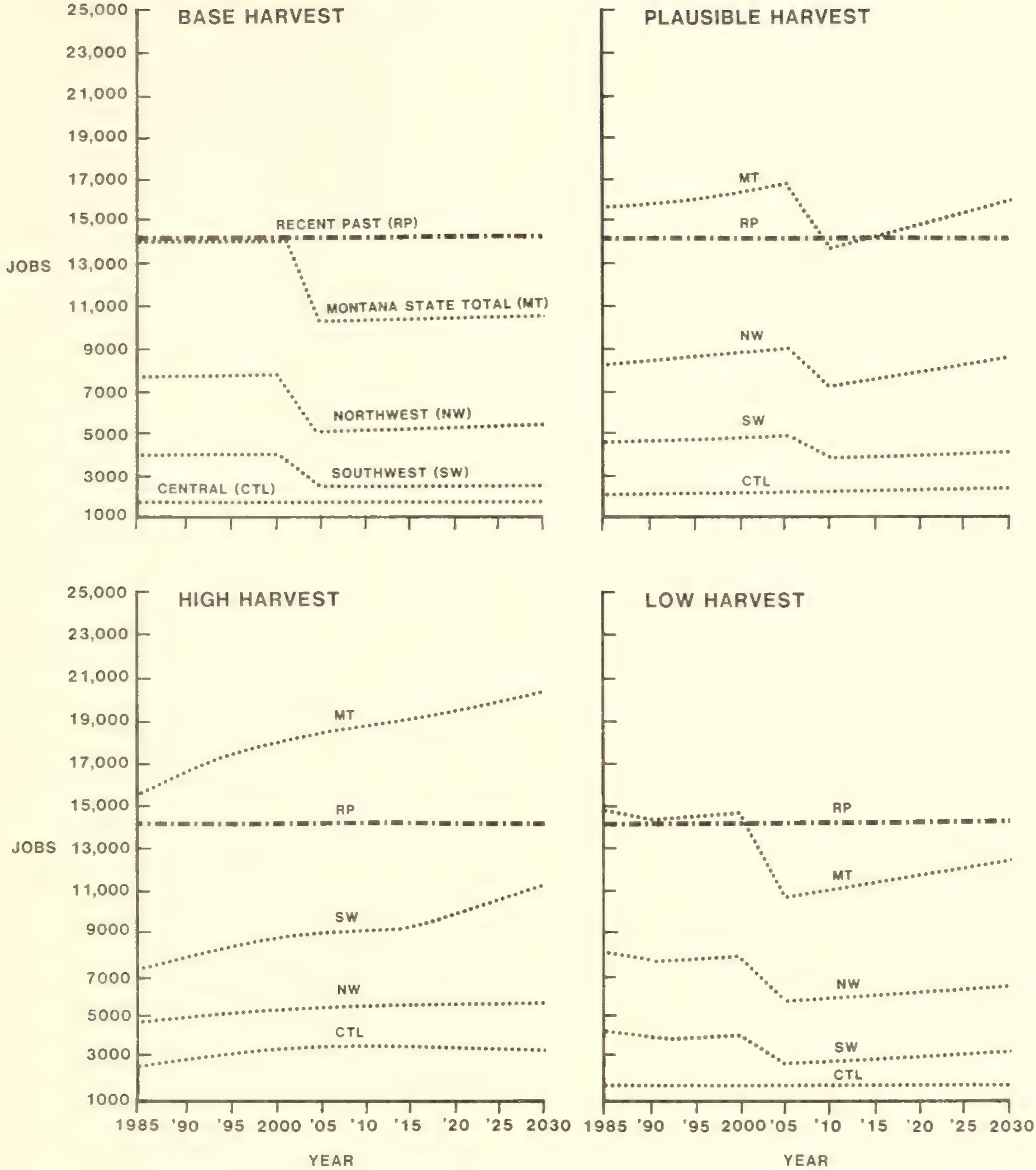

Figure 10—Total timber-related employment, by scenario and region.

Estimates of future stumpage prices can be most meaningfully expressed in relative terms, the rank order of different timber-related scenarios. (Comparisons of absolute dollar levels are not as meaningful and are not discussed in this analysis.) The relative rankings (where 1 = the smallest and 4 = the largest) in terms of the level of stumpage price and size of price change over the period 1985 through 2030 are:

	Stumpage price ranking	
Scenario	Level	Change
Base Harvest	4	4
Plausible Harvest	2	2
High Harvest	1	1
Low Harvest	3	3

As expected, timber-related scenarios with the highest harvest level have the lowest prices and the smallest increase in real dollar values. Scenarios with lower harvest levels, such as the Base Harvest and Low Harvest scenarios, have higher initial prices for stumpage as well as larger increases. The Base Harvest scenario has a larger increase in prices as well as higher prices in general because it actually has a lower harvest in the more distant future than does the Low Harvest scenario. The rate of increase in stumpage prices is not as meaningful and is not displayed because a small increase applied to low initial price can result in high percentage increases. In general, the rate of increase in real prices is consistent with those used in the Resources Planning Act Assessment (Haynes 1986).

The statewide demand for timber is inelastic (Jackson 1983) for the range of prices and volumes considered in this analysis. It follows that increases in stumpage prices result in less-than-proportionate decreases in the quantity of stumpage demanded and that gross stumpage revenue to producers would fall as the volume marketed increases. Conversely, as prices rise, less-than-proportionate decreases in the quantity of stumpage demanded would result in increases in total revenue. These results occur only if all the other variables used to specify the demand and supply model are held constant and there is no shift in demand.

Stumpage revenues to specific ownership classes vary depending on the characteristics of the timber marketed, location factors, and the strength of the local stumpage market. All of the Forest Service planning alternatives considered in this study show some relative increase in the Forest Service's share of the stumpage market and will result in commensurate increases in gross stumpage receipts, even though statewide receipts may be dropping. In the Plausible Harvest and High Harvest scenarios, the increases are substantial. Shifts in total State timber harvest between substate regions in these scenarios mean that the changes in revenues would be most noticeable in the northwest and southwest substate regions.

DISCUSSION

This study sought to assess the extent to which Montana's timber inventory could support various combinations of mill processing and timber harvest levels to the year 2030. The study also measured the effect of these combinations in terms of their inventory and economic implications.

But as in any projection into the the future, the confidence in the assessments decreases as the time horizon is lengthened. In this study, we feel more confident about the quality of our simulated futures over the first two or three decades than over the later two or three decades. Inability to correctly project biological and economic information to 2030 is one source of uncertainty. Another is that land management planning, being a continuing process on National Forests, may create other preferred alternatives during subsequent rounds of planning, altering or eliminating those used in this study.

A number of critical assumptions and limitations should be emphasized:

1. Potential regional supply problems identified here are conditioned by 1980 log flow patterns. Market forces could alter these patterns so that regionally specific surpluses or deficits projected by the model would be reduced. Modifications in log flows (both inside Montana and between Montana and other States and Canada) or the geographical distribution of processing capacity could not be anticipated and modeled in this study. Nevertheless, while some adjustments will almost certainly take place to help alleviate surpluses and deficits, there are limits. For example, distance, terrain, and location of processing centers would probably limit the large-scale movement of logs from the central to the northwest region.
2. In an open market, price change is the mechanism by which supply and demand are brought into equilibrium. Statewide shortages or surpluses resulting in the comparison of predetermined supply with predicted demand should be used for reference and comparison only. We do not expect disequilibrium. Rather, projected surpluses and shortages will be eliminated by price changes and changes in log movements.
3. Not all the total physical inventory was always used in MTMM simulations. In each National Forest planning alternative, only a portion of the total physical timber resource on each Forest is actually included in the alternative's "suitable" land base. Similar reductions in the potential timber land base have been applied to private and Department of State Lands ownerships. If these reductions are overestimated, they will cause an underestimate of future inventory, making future timber scenarios appear unnecessarily bleak. On the other hand, some inventories may have been overstated. For example, we did not account for the fragmented ownership pattern of Department of State Lands resulting in a substantial portion of such lands being physically or economically inaccessible, especially in the central region. Similarly, harvest behavior of the nonindustrial private sector is unpredictable, yet we treated it as a certainty.
4. Overrun, lumber price, and production cost projections all have a dramatic effect on the price and equilibrium quantity projections in the supply-demand model. Therefore, modest errors in these projections will result in gross errors in price and quantity projections.
5. The accuracy of each scenario depends on the indicated harvests actually occurring. For all public agencies the level of timber sold depends on funding for sale preparation and administration as well as construction of access roads. The analyses in this study were made on the basis of volumes provided in the draft Forest Plans and do not reflect any subsequent adjustments that may be made.
6. This study only partially accounts for market forces arising outside Montana. We did not account for any changes in import and export relationships between Montana and nearby States nor changes involving relations with Canada. Similarly, we did not attempt to evaluate implications of national policy changes, such as the change in capital gains tax treatment specified by the 1986 Tax Reform Act.

7. This study did not distinguish between species and their relative desirability or marketability because the timber inventory maintained in MTMM is not species-specific. Our results pertain to a generic cubic or board foot that we assume the mills will want. This approach is compatible with the movement toward a fiber-oriented forest products industry.

8. The growth rates for all ownership classes included in the model are set at those indicated at the present time from timber inventory data. As such, there is no consideration given to future increases in growth rates that could result from past activities or from future cultural activities. Consequently, the inventory futures portrayed in this report are conservative and can be dramatically altered by reaping benefits of cultural practices.

Seven key conclusions can be drawn from this study:

1. The featured scenarios portray strikingly similar futures, regardless of geographical area. The Base and Low Harvest scenarios depict an extension of the recent past until about 2000, when substantial declines occur. The Plausible Harvest scenarios suggest a future that is modestly above or approximates the recent past level of activity. High Harvest scenarios depict modest but constant expansion throughout the analysis.

2. Supply problems are a strong possibility in the northwest region assuming current patterns of log flows continue. Supply problems are likely to be less in the southwest region, unless log flow patterns change to benefit the northwest. This is because, under the current conditions, a substantial amount of the logs processed in the southwest come from timber harvested in the northwest. Supplies in the central region seem to be generally adequate, somewhat above the levels of the recent past. If problems arise, they tend to occur well into the next century, and then only under circumstance of restricted harvest levels or high processing levels.

3. Industrial owners do not appear to have sufficient inventory to maintain their harvest at the level of the recent past. The level of harvest is projected to begin declining about the year 2000 at the latest and decline to a level less than half of current levels in all but the High Harvest scenario. This decline in industry harvest, due to inventory depletion, is most significant in the northwest substate region of Montana, but it is also sizable in the southwest section. However, the MTMM figures probably exaggerate the speed and depth of the decline. More likely, industry harvest will decline in a series of smaller, more prolonged stops as individual owners make adjustments to their inventory.

4. Timber harvest in Montana need not drop below that of the past. Even at harvest levels projected in the Plausible Harvest scenario, total statewide harvest is equal to or above the recent past average for all of the analysis period. The significant declines by industry can be at least partially offset by increases in National Forest harvest, depending on Forest planning decisions. A potential also exists for nonindustrial private owners in the central and southwest regions to increase harvest.

5. Regardless of possible problems between timber harvest and log processing levels, Montana's timber inventory should remain in good shape. Statewide growing stock levels generally increase throughout the analysis period. Moreover, as industry harvest declines, growing stock takes an even greater upturn. Growth-to-cut ratios exceeding 1.0 imply inventory buildup.

6. These trends have many economic implications. Because timber-related employment and income are assumed proportional to timber harvests, and because harvest levels are expected to increase in both the Plausible Harvest and High Harvest scenarios, opportunities may exist for economic development based on the forest products industry. Any expansion would be closely tied to changes in markets, technology, and resource availability—all oriented toward using smaller trees. The other two featured scenarios portray a situation in which, at best, employment levels stay at about current levels. The only possibility for increased employment in those scenarios would be an increase in employment per unit of timber production. However, current trends show decreases in employment per unit of timber production. Substantial increases in real stumpage prices can be expected in all but the High Harvest scenario. In general, the lower the quantity of timber that would be marketed over time, the larger the increase in the real price of stumpage.

7. A shift to harvesting smaller diameter trees is expected. By 2030 harvest will largely come from 8-inch to 12-inch trees rather than from 14-inch to 18-inch trees, as simulated by MTMM for 1985. This shift will have a major impact on Montana's wood products industry both in the woods and in the factory. For one thing, logging costs would be expected to increase because it is generally more costly per unit volume to remove smaller trees than larger trees. This cost increase may be mitigated by increased mechanization in harvesting that is better suited to smaller trees. Also, smaller diameter trees would probably cause major changes in the structure of the wood-processing industry. This would result in closures of mills reliant on large logs (plywood mills and dimension-lumber mills) and openings of mills that could more efficiently use small logs (stud mills and pulp mills). Indeed, this process is already under way.

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A simulation model was used to evaluate the potential for future timber harvest levels to meet various expectations of log processing needs and to assess associated inventory and economic impacts in Montana. For the State as a whole, future harvest levels appear to be adequate to accommodate a range of log processing levels. Harvest levels may not meet future log processing needs in the northwest region of Montana. A reduction in statewide industrial harvest appears inevitable. Growing stock inventories will generally increase. A shift in harvest to substantially smaller timber is expected. Stumpage prices are expected to increase.

KEYWORDS: timber, supply and demand, economic analysis

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